Decision Making

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Lecture 17a

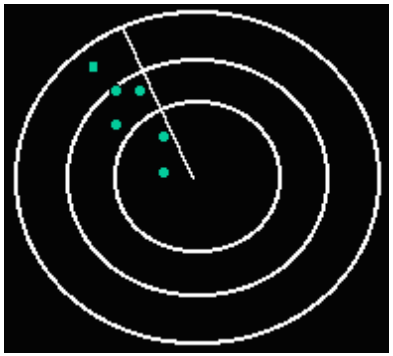
Massachusetts Institute of Technology

Overview

- Decision Making
  - Information processing and Signal Detection Theory (P&V, Chapter 4)
  - Normative and descriptive models of judgments and decisions
  - Naturalistic decision making
- The FAA from a Human Factors Perspective

Examples of Signal Detection Tasks

- Determining sensory thresholds
- Airport security screening
- Identify friend or foe
- Lie detectors
- Detecting cancerous cells



Friend or foe?

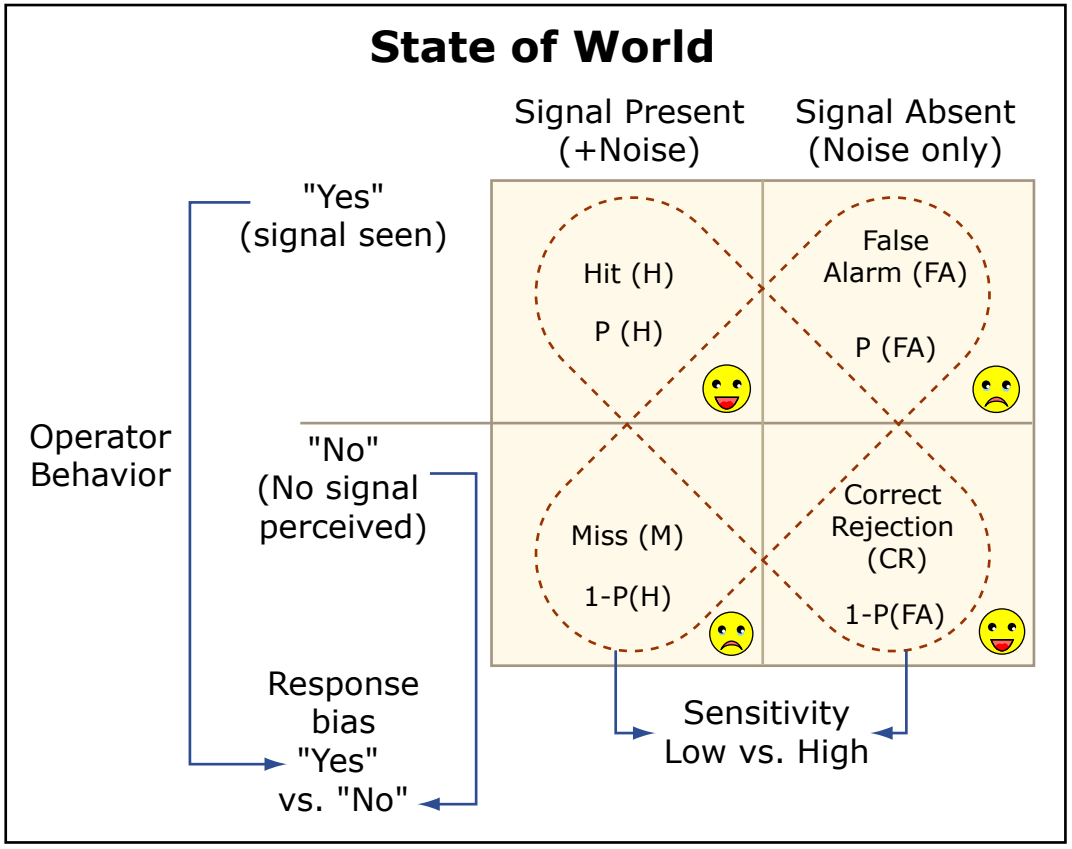
What are the common threads?
These are situations that are not clear cut.
Some errors and some correct choices are made.
Speed of response is not a factor, accuracy is the focus.
Training/practice can be a factor.

Key Terms

- Sensitivity (d’)
  - Ability to separate the signal from noise
  - Better (higher) with practice, for an easier task, or for particular individuals
- Bias (β) (criterion)
  - Conservative vs. liberal

    (accept nothing vs. accept everything)

Signal detection theory



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ROC: Receiver operator characteristic

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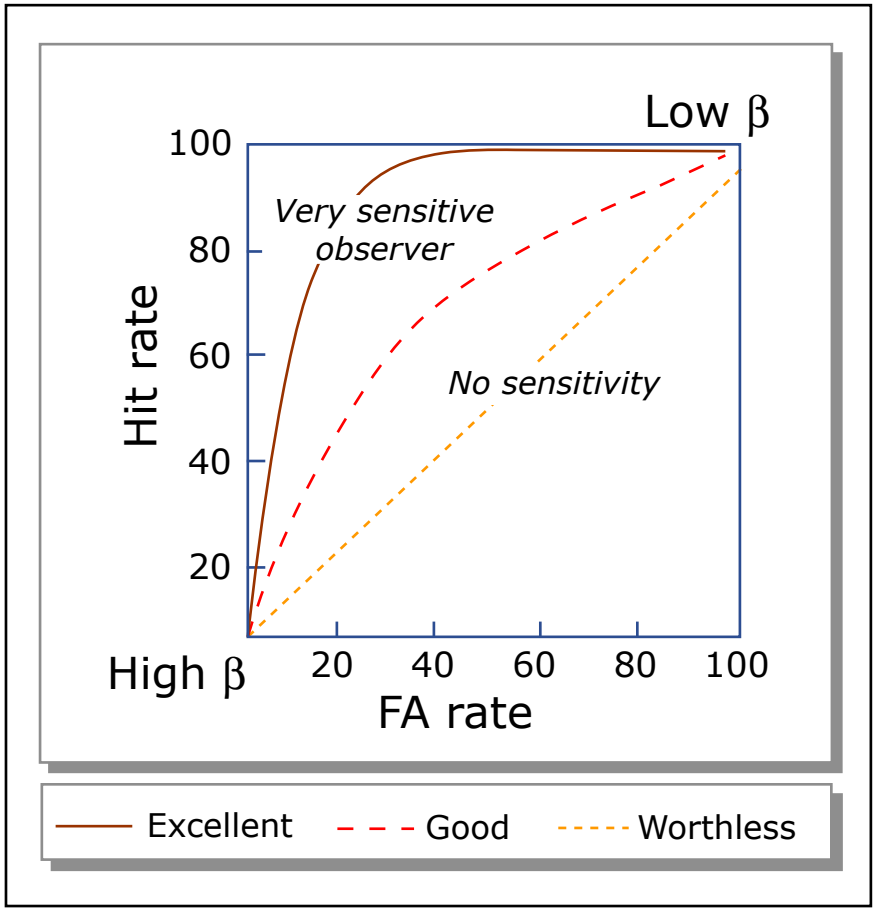
Good sensitivity:

High hit rate + low FA

Bad sensitivity:

Same number of hits and FA



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Data for an ROC Curve

- To generate different points on the curve (i.e., to vary bias), alter
  - Subject instructions to be more or less conservative
  - Payoffs for hits/misses
  - Base frequencies of signal occurrence

Relations to hypothesis testing

- Null hypothesis, H0: the signal is absent from the data
- Alternative hypothesis, H1: the signal is present
- There are two kinds of errors:
  - Type I: choosing H1 when H0 is true => FA
  - Type II: choosing H0 when H1 is true => Miss

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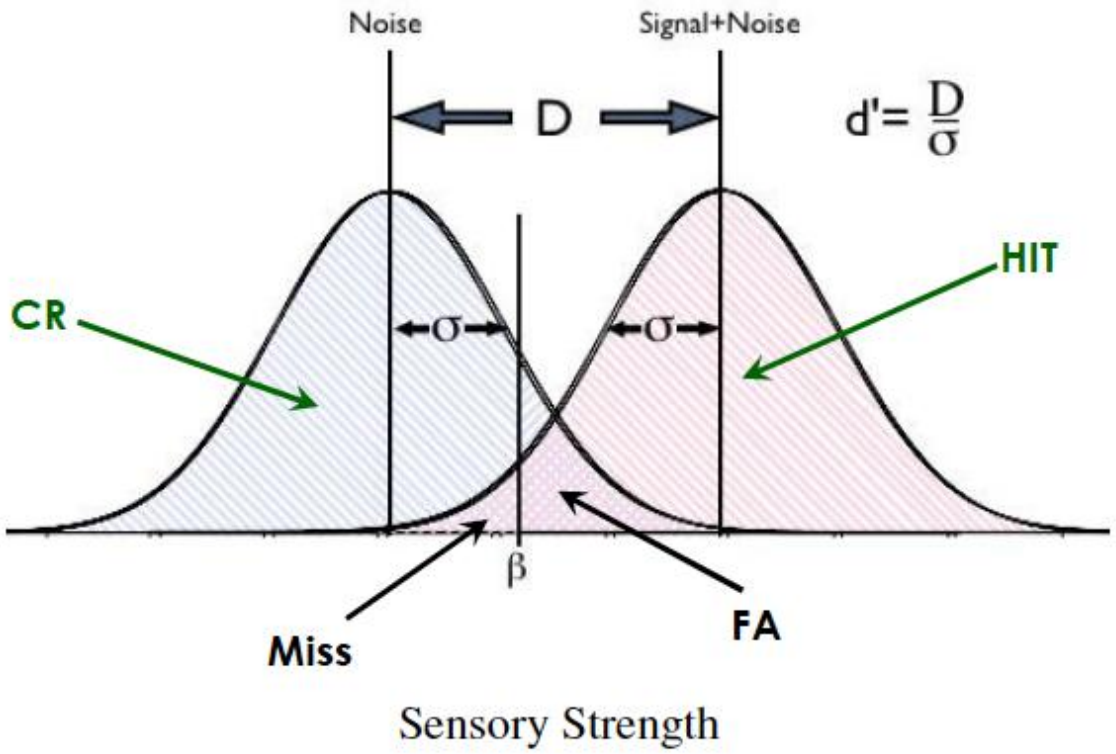
Signal detection theory



Picture from : http://www.csic.cornell.edu/201/signal_detection/

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ROC: Receiver operator characteristics

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"Figure 4: Internal response probability of occurrence curves and ROC curves for different signal strengths." Image removed due to copyright restrictions. Original image can be viewed here: http://www.cns.nyu.edu/~david/handouts/sdt/sdt.html.

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Signal Detection Links

- Demonstration
  - http://www.cogs.indiana.edu/software/SigDetJ2/index.html
- To create graphs by entering data
  - http://wise.cgu.edu/sdtmod/index.asp
- To manipulate graphs interactively
  - http://cog.sys.virginia.edu/csees/SDT/index.html

Observations about "Simple" Judgments and Decisions

- Examples
  - What can I guess about someone I just met?
  - Are people in Minnesota taller on average than people in Massachusetts?
  - What should I wear today?
  - Should I buy a lottery ticket? (and other financial decisions)
- Common Threads
  - Not a lot of formal reasoning
  - Specific data are accessible/available/known, but not always considered accurately (cognitive biases)
  - Make the judgment/decision and move on (tactical)

Normative vs. Descriptive Models

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Normative Models

- List options
- Remember, gather, perceive all associated information and cues
- For each option, list possible outcomes
  - Costs
  - Benefits/values
  - Risks
- Assign probabilities
- Chose option with highest utility (Bayesian logic)

Descriptive Models (Reality)

- Use heuristics
- May not think of all options
- Resource limitations
  - Incomplete information
  - Time constraints
  - Cognitive
    - Memory
    - Attention
- May be biased
  - Transitivity & framing
  - Bounded rationality
  - Satisficing

Reasoning

- Deductive reasoning
  - Formal logic

$x \rightarrow y$	If x then y.
$\neg y$	"not y"
$\therefore \neg x$	Therefore "not x."

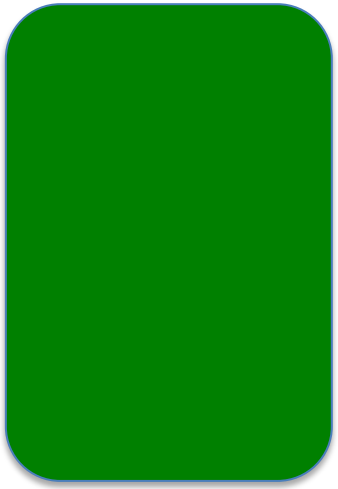
- Inductive reasoning (generalization)
  - Drawing a conclusion from a set of data
  - Basis for scientific reasoning, prototyping, classification into groups, and analogy-based reasoning

Example: Hypothesis Testing

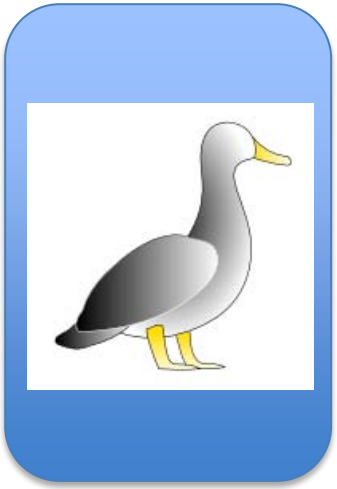
- You have a deck of cards with colors on one side and animals on the other.
- Hypothesis:

  All cards with a 4-legged animals are green on the back.
- Which cards would you flip over to test your hypothesis?

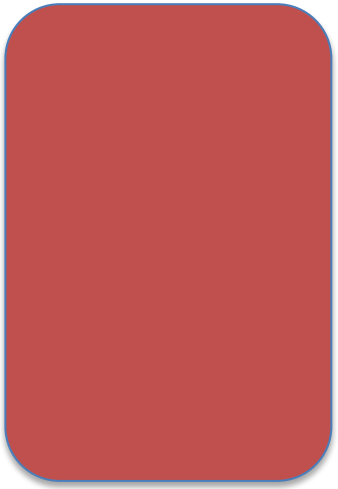
Rabbit



Green



Duck



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Heuristics and Cognitive Biases

- Hindsight bias, Gambler's fallacy, sunk costs, and many others
- Availability and representativeness heuristics
  - Tversky & Kahneman
- Hypothesis testing
  - Confirmation bias
    - e.g., watching a particular news outlet
    - Also, automation bias

Naturalistic Decision Making

- Ill structured problems
  - Uncertain dynamic conditions
- Shifting goals
- Action feedback loops
- Time pressure
- High risk
- Multiple players
- Organizational norms
- Domains: Military command and control, aviation, emergency/first response services, process control, medicine

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Complex/Naturalistic Decisions

- Examples
  - Should I fly today or not? (go/no-go decision)
  - While airborne, should I continue my flight or land?
  - What career should I pursue?
  - What should I do when events don't go as planned?
- Common threads
  - On-going/continuous decision making (strategic)
  - Plenty of thought/data collection, mental modeling, and projection (situation awareness)
  - Personality is a factor

AOPA Air Safety Institute Decision Making Webinar

- Decision making is a continuous process
  - Anticipate, recognize, evaluate options, act (repeat)
- Keep on guard, pessimism is good
- Slow emergencies vs. fast emergencies
  - e.g., flight into IMC vs. engine failure
- Rehearse, practice, checklists
  - Aviate, navigate, communicate, and “hesitate”
  - Think through the problem, analyze

http://www.aopa.org/asf/webinars/

AOPA ASF Decision Making Webinar Continued

- Priorities
  - Survive unharmed, save the aircraft, reach your destination
- Making the best decision (maybe out of all bad options)
- Aeronautical decision making factors
  - "Hazardous attitudes"
    - Macho, antiauthority, impulsivity, invulnerability, resignation
  - Experience, a double edged sword
  - External pressures (e.g., what others expect/say/do, time to return aircraft)

http://www.aopa.org/asf/hotspot/decisionmaking e.g., audio at 24:20

AOPA ASF Decision Making Webinar Continued

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- Know your own ‘weak spots’
- Have a backup plan
- Under-promise
- Be well prepared before the flight

Image of N3609 crash removed due to copyright restrictions.

The investigation begins…

Decision Making & Behaviors

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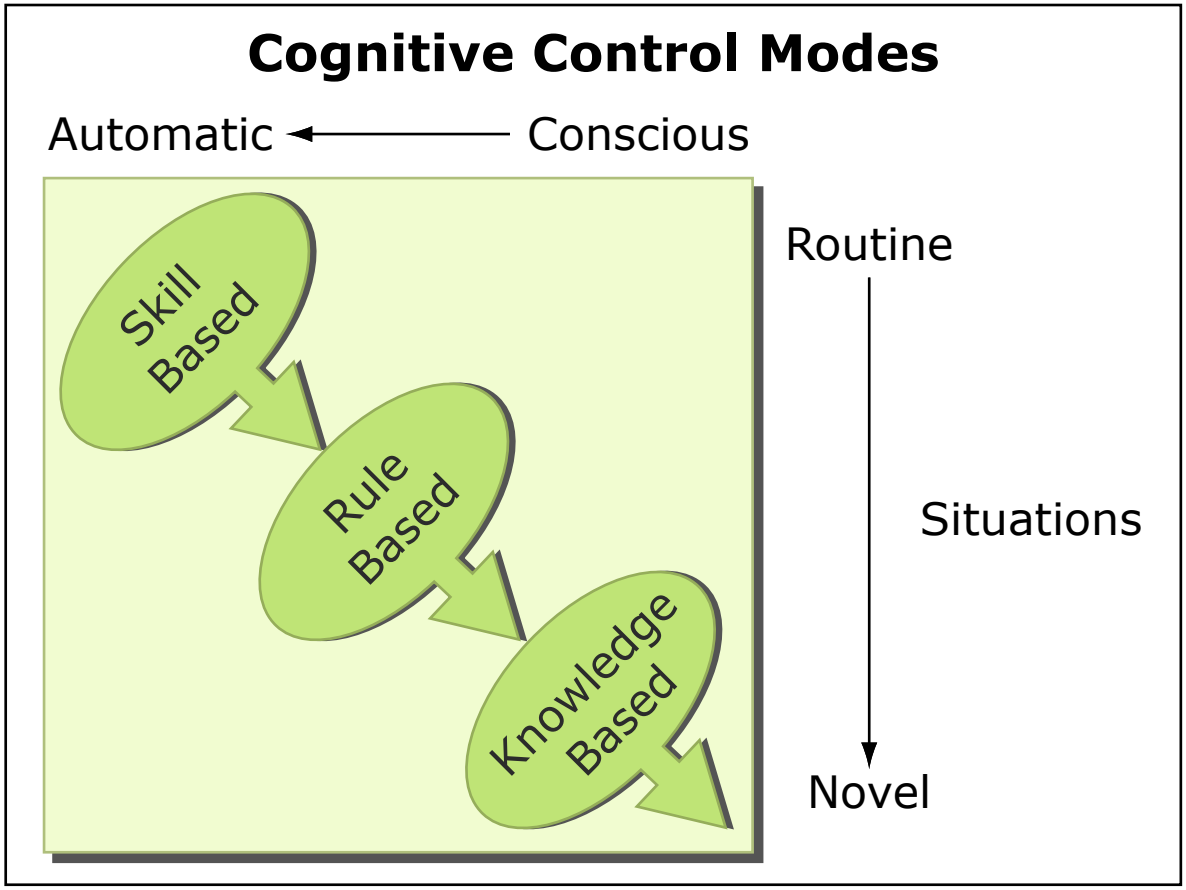

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Expert Decision Making

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- Experts tend to develop a single option as opposed to multiple
  - Satisficing vs. optimal
  - Experts vs. novices
- Recognition primed decision making
  - Naturalistic decision making
  - Pattern recognition
    - Mental Simulation
  - Cues
  - Expectancies
  - Goals
  - Action

Image of airplane water landing removed due to copyright restrictions.

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Hudson miracle approach graphic removed due to copyright restrictions. Original image can be viewed here: http://ww1.jeppesen.com/documents/corporate/news/US_Airways_Flight_1549_Sully_Skiles_Hudson_River_Miracle_Apch_Chart.pdf

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